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Effect of Sowing Environment and Varieties on Growth Attributes of Rain-fed Wheat under Sub-tropical Foothills of Jammu

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ABSTRACT

A field experiment was conducted at the Research Farm Advanced Centre for Rain-fed Agriculture (ACRA), Rakh-Dhiansar of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The experiment was laid out in factorial randomized block design with three replications at during *Rabi* season of 2018-19 to study the effect of six dates of sowing (31st October, 15th November, 30th November, 15th December, 30th December and 14th January) on growth attributes of two wheat varieties (*PBW-175* and *JAUW-598*). The sowing of rain-fed was done at spacing of 20 cm in sandy loam soil. The observations were recorded on plant height, total dry matter accumulation, crop growth rate and relative crop growth rate of wheat crop. Growth of wheat in terms of plant height, dry matter accumulation, crop growth rate and relative growth rate at periodic intervals revealed that at all the growth stages, the growth characters of wheat showed a pronounced improvement with varieties and sowing environments. The data showed significant effects of different sowing time on plant height, total dry matter and crop growth rate while relative crop growth rate found to be non-significant. Among varieties total dry matter found to be significant at 90, 120 DAS and at harvest as well as CGR at 60-90 DAS and 90-120 DAS while plant height and RGR showed to be non-significant at periodic intervals. In addition, the interaction effects were significant in some of observations.

Keywords- Crop growth rate, Dry matter accumulation, Plant height, Relative growth rate, Wheat.

I. INTRODUCTION

Wheat, (*Triticum aestivum* L.) belonging to family "Gramineae" and genus "Triticum", is one of the world's most widely cultivated food grain crops due to its wider adaptability to different agro-climatic and soil conditions. This nutrient-rich cereal is one of the most important staple food crops of many countries including India. Sowing environment plays an important role in productivity of wheat. Generally, wheat like other cool season crops is seeded early to take maximum period for growth and development toward maturity before the possible heat stress. Early planting may avoid terminal heat stress by facilitating the grain filling during relatively cooler temperatures (Loss and Siddique 1994). Normally the wheat crop is sown in about 148 thousand hectares of

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rain fed sub-tropical areas of Jammu region during the first fortnight of November, however if no rains are received during this period and the soils have insufficient soil moisture, the sowing of wheat may be extended to December under late situations and even in January during very late situations. It has been realized that the average yield of wheat of this region, sown during the month of November, is comparable to the state average, but the declining trend in wheat yield has been noticed with delayed sowing which can be attributed to shorter growth period available coupled with higher temperatures and hotter winds during reproductive growth period, which leads to forced maturity and ultimately poor grain yield.

Growth refers to biomass accumulation and can be measured by leaf area, shoot, root and total weights, or plant height, and these can be used to compare growth within cultivars or between cultivars. The term growth also applies to quantitative changes that occur during development and maybe defined as an irreversible change in the size of cells, organs or whole organisms. Growth also can be defined as progressive development of an organism. The techniques used to quantify components of crop growth are collectively known as growth analysis.

II. MATERIALS AND METHODS

A field experiment was carried out at Rakh-Dhiansar during the *Rabi* season of 2018-19. Geographically, the experimental site was located at 32o 39 'N latitude and 74o 53 'E longitude with an altitude of 332 m above mean sea level in the Shivalik foothills of North-Western Himalayas sub-tropical region. The experiment comprised of two wheat varieties (*JAUW-598* and *PBW-175*) under six different dates of sowing (31st October, 15th November, 30th November, 15th December, 30th December and 14th January) and was laid out in factorial randomized block design with three replications. All agronomic practices were kept normal and uniform for all the treatments. For all the growth and development studies during the crop growth period, five plants were selected randomly and tagged in each plot except for that of dry matter accumulation where plants from border rows were selected. Initially the growth parameters were recorded at 30 DAS and subsequent observations were taken at an interval of 30 days. The height of wheat plant was measured with the help of meter scale from the base of the plant to the tip of the last fully opened leaf at 30, 60, 90 and 120 DAS and at harvest and is given in cm. Average of all the five plants was taken for statistical analysis. Plant samples for dry matter accumulation were taken from running meter row length from the second and third rows from the west at different growth stages i.e., at 30, 60, 90, 120 DAS and at harvest. The plants were cut from the ground level and reported in g/m2 after sun drying and thereafter shifted in the oven to dry at a temperature of 65±5°C till a constant weight was achieved. The increase in plant material per unit time or cumulative crop growth rate (CGR) was calculated as per the formula given by Radford (1967) and was expressed as gram per square meter per day (g/m^2/day).

$$\boldsymbol{CGR = \frac{W2 - W1}{T2 - T1}}$$

Where, W1= total dry matter of crop plant at the time interval t1 and W2= total dry matter of crop plant at the time interval t2

The increase in plant material per unit dry matter per unit time (RGR) was calculated as per the formula given by Radford (1967) and was expressed as gram per gram per day (g/g/day).

$$\mathbf{RGR = \frac{Log\ W2 - Log\ W1}{T2 - T1}}$$

Where, W1= total weight of crop plant at the time interval T1 and W2= total weight of crop plant at the time interval T2

III. RESULTS AND DISCUSSION

Plant Height

The data depicted in Table 1 showed that plant height gradually increased with crop age and attained a maximum at harvest. Further, the plant height of wheat variety *PBW-175* at periodic intervals was slightly more as compared to wheat variety *JAUW-598*. These results are in close conformity with those reported by Mukhtarullah and Akmal (2016) and Wahid *et al*., (2017). Among sowing environments, 31st October sown wheat crop had significantly more plant height at periodic intervals and at harvest which was statistically at par with 15th and 30th November sown wheat crop. Significantly lower value of plant height was recorded with 14th January sown wheat crop being statistically at par with 30th and 15th December sown wheat crop. Early sown crop may have enjoyed the better environmental conditions especially the temperature and solar radiation which resulted in tallest plants. Further, reduction in plant height, in late sowing might be due to shorter growing period. When the crop is sown late, its flowering period is shortened because by the time it comes to flowering, the atmospheric temperature starts rising. The interaction effects of varieties and sowing environments on plant height of wheat crop failed to show significant differences at periodic intervals during growing season of Rabi 2018-19. Similar findings were also reported by Singh *et al*., (2021), Chauhan *et al*., (2020), Madhu *et al*., (2018) and Wahid *et al*., (2017).

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Table 1: Effects of varieties and sowing environments on plant height (cm) of wheat

Treatment Combination	Days After Sowing (DAS)				
	30	**60**	**90**	**120**	**At harvest**
Factor (A) Varieties					
PBW-175	14.48	31.38	76.73	95.61	95.18
JAUW-598	14.37	30.60	75.52	96.29	95.89
SEm±	**0.25**	**0.56**	**1.43**	**1.89**	**2.01**
CD (5%)	**NS**	**NS**	**NS**	**NS**	**NS**
Factor (B) Sowing Environment					
31st October	15.84	33.58	82.22	102.16	101.55
15th November	15.60	32.69	79.88	100.81	100.38
30th November	15.29	32.33	78.51	100.34	99.70
15th December	13.79	29.46	74.74	94.53	94.20
30th December	13.18	29.22	72.87	91.55	91.10
14th January	12.84	28.67	68.54	86.32	86.30
SEm±	**0.44**	**0.97**	**2.49**	**3.28**	**3.48**
CD (5%)	**1.29**	**2.85**	**7.29**	**9.61**	**10.19**
Interaction (A*B)	**NS**	**NS**	**NS**	**NS**	**NS**

Total Dry Matter Accumulation

The data regarding total dry matter accumulation as shown in the Tables 2 and 3 revealed that wheat variety *JAUW-598* resulted in significantly higher dry matter accumulation till harvest except for that at 30 DAS. The increase in dry matter accumulation might have been due to cumulative vigorous growth which in turn put forth more photosynthetic surface, chlorophyll formation, biomass, smothering weeds and higher nutrient uptake. Almost the similar findings were also reported by Chauhan *et al*., (2020) and Reddy *et al*., (2020). In case of dry matter accumulation, 31st October sown wheat crop resulted in significantly more dry matter accumulation at periodic intervals and at harvest which was statistically at par with 15th November sown wheat crop. January 14th sown wheat crop had significantly lowest dry matter accumulation at periodic intervals and at harvest which was statistically at par with 30th December sown wheat crop only at 30 DAS. This can probably be attributed to the relatively better and congenial environment available throughout the crop growth period from sowing to harvest in 31st October and 15th November sown wheat crop. Also, 31st October and 15th November sown wheat crop might have exposed to suitable ambient and soil temperatures which were favorably placed within the cardinal limits along with other atmospheric conditions which led to early germination, seedling establishment, ensured proper initial crop stand, thus leading to better vegetative growth and dry matter accumulation which could ultimately be partitioned towards prospective sinks or grains besides in realizing the sink capacity of the individual plant. As the interaction effects of varieties and sowing environments, the interactive effects were found non-significant at 30 and 60 DAS. At 90 DAS, the dry matter accumulation of wheat crop with almost all the sowing environments significantly increased with Variety *JAUW-598* as compared to variety *PBW-175* except for that at 31st October and 15th November sowing environments. Also, with respect to performance of individual varieties at different dates, a conspicuous decline in dry matter production was recorded with each 15 days of delay in sowing time. The decline however, remained statistically similar at all sowing environments successively with wheat variety *JAUW-598* and up to 15th November and beyond 30th December sowing time successively with wheat variety *PBW-175* but a significant decrease was observed after 15th November till 30th December with *PBW-175* wheat variety. Almost similar interactive effects were observed at 120 DAS and at harvest. These results are in close conformity with those reported by Singh *et al*., (2022), Reddy *et al*., (2020) and Chauhan *et al*. (2020).

Table 2: Effects of varieties and sowing environments on total dry matter accumulation (g/m^2) of wheat

Treatment Combination	Days After Sowing (DAS)				
	30	**60**	**90**	**120**	**At harvest**
Factor (A) Varieties					
PBW-175	40.45	94.59	226.43	473.75	535.73
JAUW-598	41.72	105.44	281.94	563.77	633.61

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SEm±	**0.79**	**2.01**	**4.89**	**10.20**	**12.37**
CD (5%)	**NS**	**5.90**	**14.34**	**29.91**	**36.28**
Factor (B) Sowing Environment					
31st October	50.25	120.30	316.72	631.12	733.78
15th November	47.63	113.65	306.74	619.49	714.74
30th November	42.92	101.67	275.77	561.54	649.04
15th December	42.75	97.67	242.65	497.30	557.30
30th December	31.87	88.83	205.22	424.43	461.93
14th January	31.11	78.00	178.02	378.70	391.20
SEm±	**1.37**	**3.48**	**8.47**	**17.66**	**21.43**
CD (5%)	**4.03**	**10.21**	**24.84**	**51.81**	**62.85**
Interaction (A*B)	**NS**	**NS**	**S**	**S**	**S**

Table 3: Interaction effects of varieties and sowing environments on total dry matter accumulation (g/m^2) of wheat

Variety × Sowing Environment (A×B)	Days After Sowing (DAS)					
	90		120		At harvest	
	PBW-175	***JAUW-598***	***PBW-175***	***JAUW-598***	***PBW-175***	***JAUW-598***
31st October	306.76	326.69	619.85	642.38	722.19	745.38
15th November	297.53	315.96	610.06	628.91	704.58	724.91
30th November	255.09	296.45	530.17	592.91	615.17	682.91
15th December	207.94	277.37	439.87	554.73	489.87	624.73
30th December	157.57	252.86	343.17	505.73	373.13	550.73
14th January	133.71	222.33	299.42	457.99	309.42	472.99
SEm±	**11.98**		**24.98**		**30.30**	
CD (5%)	**35.14**		**73.26**		**88.88**	

Crop Growth Rate

Increased in crop growth rate could be attributed to higher dry matter accumulation at periodic intervals. Crop growth rate of wheat crop increased in magnitude during the initial crop growth stages and then declined due to senescence as showed in the Tables 4 and 5. Wheat variety *JAUW-598* resulted in higher crop growth rate at 30-60, 60-90 and 90-120 DAS. In case for crop growth rate, 31st October sown wheat crop resulted in significantly higher crop growth rate at each succeeding observations which was statistically at par with 15th November sown wheat crop, whereas significantly lowest crop growth rate was registered with 14th January sown wheat crop. The increasing trend in terms of crop growth rate of wheat under sowing environments could have been due to lower weed density and weed biomass leading to efficient utilization of moisture, nutrients, space and light resulting in optimum growth characters. In relation to effects of varieties and sowing environments, at 60-90 DAS, the crop growth rate of wheat at almost all the sowing environments significantly increased with variety *JAUW-598* as compared to variety *PBW-175* except for that at 31st October and 15th November sowing environments. Also, with respect to enactment of individual varieties at different dates, a remarkable decline in crop growth rate was recorded with each 15 days of delay in sowing time. The turn down however, remained statistically at par at all sowing environments continually with wheat variety *JAUW-598* and up to 15th November and beyond 30th December successively with wheat variety *PBW-175* but a significant decrease was observed after 15th November till 30th December with *PBW-175* wheat variety. Almost a similar interactive effect was observed at 90-120 DAS. These results are in conformity with the findings of Singh *et al*., (2017) and Valero *et al*., (2005).

Table 4: Effects of varieties and sowing environments on crop growth rate (g/m^2/day) of wheat

Treatment Combination	Days After Sowing (DAS)		
	30-60	**60-90**	**90-120**
Factor (A) Varieties			
PBW-175	1.80	4.39	8.25
JAUW-598	2.01	5.88	9.40

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SEm±	**0.04**	**0.09**	**0.12**
CD (5%)	**0.12**	**0.27**	**0.35**
Factor (B) Sowing Environment			
31st October	2.29	6.55	10.48
15th November	2.13	6.44	10.42
30th November	1.88	5.80	9.53
15th December	1.82	4.83	8.49
30th December	1.79	3.88	7.31
14th January	1.53	3.33	6.69
SEm±	**0.07**	**0.16**	**0.21**
CD (5%)	**0.21**	**0.47**	**0.61**
Interaction (A*B)	**NS**	**S**	**S**

Table 5: Interaction effects of varieties and sowing environments on crop growth rate (g/m^2/day) of wheat

Variety × Sowing Environment (A×B)	**Days After Sowing (DAS)**			
	90		**120**	
	PBW-175	***JAUW-598***	***PBW-175***	***JAUW-598***
31st October	6.43	6.67	10.44	10.52
15th November	6.32	6.55	10.42	10.43
30th November	5.33	6.28	9.17	9.88
15th December	3.81	5.86	7.73	9.26
30th December	2.52	5.24	6.19	8.43
14th January	1.97	4.70	5.52	7.86
SEm±	**0.23**		**0.29**	
CD (5%)	**0.67**		**0.86**	

Crop Relative Growth Rate

For both wheat varieties, relative growth rate of wheat at periodic intervals were not significant. Relative growth rate of wheat was not significant for all sowing environments. It is apparent from the Table 6 that the relative growth rate of wheat crop was not significantly influenced by varieties and sowing environments and their interactions in the growing season of the crop. These results are in close conformity with those reported by Ahmed and Farooq (2013).

Table 6: Effects of varieties and sowing environments on relative growth rate (g/g/day) of wheat

Treatment Combination	**Days After Sowing (DAS)**		
	30-60	**60-90**	**90-120**
Factor (A) Varieties			
PBW-175	1.92	2.27	2.58
JAUW-598	1.96	2.38	2.67
SEm±	**0.05**	**0.06**	**0.07**
CD (5%)	**NS**	**NS**	**NS**
Factor (B) Sowing Environment			
31st October	2.02	2.43	2.71
15th November	2.00	2.42	2.71
30th November	1.95	2.37	2.67
15th December	1.93	2.31	2.61
30th December	1.90	2.23	2.54
14th January	1.84	2.17	2.49
SEm±	**0.12**	**0.14**	**0.16**
CD (5%)	**NS**	**NS**	**NS**
Interaction (A*B)	**NS**	**NS**	**NS**

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IV. CONCLUSION

It may be concluded based on findings that from wheat varieties, it was evident that statistically non-significant results were obtained with respect to plant height with both the wheat crop varieties but numerically higher plant height was obtained with wheat variety *PBW-175* as compared to wheat variety *JAUW-598* whereas wheat variety *JAUW-598* recorded significantly higher dry matter accumulation, crop growth rate thus, leading to higher grain and straw yield. With regard to sowing environments, it was evident from the study that 31st October sown wheat crop recorded significantly higher growth parameters *viz.* plant height, dry matter accumulation and crop growth rate.

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